# AIMER: Appraisal Interpersonal Model of Emotion Regulation, Affective Virtual Students to Support Teachers Training

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## ABSTRACT

Elementary school classrooms are emotionally stressful environments, for both students and teachers. Successful teachers use strategies that regulate students' emotions and behaviors while also controlling their own emotions (stress, nervousness). To prepare teachers for the challenges of teaching, teacher training should include emotional and behavioral management strategies. Virtual Training Environments (VTEs) are effective at providing experiences and increasing learning in many domains. Creating VTEs for teachers can improve student learning and teacher retention. We introduce our current research aimed at integrating emotionally-intelligent virtual students within a 3D classroom training system. In our simulation, virtual students' emotional states will be determined from an appraisal process of actions taken by the teacher trainee in the virtual classroom. Virtual students will then display the appropriate non-verbal behaviors and react to the teacher accordingly. We present the first steps required to implement our proposed architecture which are based on appraisal theory of emotions and emotion regulation theory.

## KEYWORDS

Classroom Simulators, Virtual Agents, Affective Computing, Appraisal Theory, Emotion Regulation

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## 1 INTRODUCTION

Over the past two decades, simulation-based virtual training environments (VTEs, real world simulations in a virtual environment) have been successfully applied in a variety of domains, e.g. firefighter training, procedural training, and safety training [25, 26, 32]. VTEs offer many advantages compared to traditional training: *first*, VTEs provide training conditions for situations that are impossible, dangerous, or too costly to reproduce (e.g. piloting a plane pilots, responding to dangerous chemical accidents); *secondly*, VTEs act as a sandbox where errors committed inside the virtual environments have no impact on reality, and allow users to repeat the training until the goals are achieved; and *thirdly*, VTEs support active learning exposing users to situations requiring their intervention, which provides a hands-on experience.

The recent progress in the development of virtual humans (VHs) [21] that can simulate human social behavior, make it possible to build VTEs designed to provide training for improving social skills. The use of emotionally intelligent VHs in VTEs has many applications such as the training of communication skills in high stress situations [30], team collaboration [3], and in a teaching context where classroom teachers can be exposed to disruptive virtual students [6, 11, 14, 17, 23].

The "illusion of life", or believability, generated by VHs has been extensively studied [2]. Physical representation is not the only parameter impacting believability [22]. Affect and social relationships are necessary features for users' the suspension of disbelief [12, 22].

Affective computing arose from this problem where researchers focus on how to create virtual emotional entities that are able to understand and express emotion [21]. In order to generate accurate emotions and behaviors, affective computing researchers, apply psychological theories of emotion [19, 31, 34] to model the mechanisms behind emotion generation [4, 10, 13]. Researchers have studied the effect affective virtual agents can have on users for different domains such as education [5], and collaboration [3].

Finally, the increase in the use of VHs to foster the training of social skills indicates that VHs could support the development of teachers' classroom management skills. We present the Appraisal Interpersonal Model of Emotion Regulation (*AIMER*, pronounced /e.me/ and meaning "to love" in French) to generate emotions and control verbal and non-verbal behaviors of virtual students. We will observe how affective virtual students can impact the engagement, presence, believability and ultimately, the transfer of learning of actual teachers using VTEs.

## 2 AFFECTIVE STUDENT ARCHITECTURE

The Appraisal Interpersonal Model of Emotion Regulation (*AIMER*) is an emotion-based architecture that enables the generation of autonomous socially-adapted behaviors. Behaviors generated by AIMER are non-repetitive as repetitiveness of game narratives increases boredom and decreases motivation to finish a game.

*AIMER* will be based on Scherer's appraisal theory of emotion [34] combined with emotion regulation theories [15, 27] to provide autonomy to the virtual students with their own affective states related to their goals, social relationships, and beliefs. Our approach to design our affective model will be done in three steps:


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**1. Emotion generation process -** Based on events taking place in the virtual classroom, AIMER will determine the virtual student's emotional states. The first step is to determine which emotions we want for our virtual students. We will consider emotions that are relevant in a classroom context with disruptive students (Sadness, Surprise, Anger, Fear, Shame, Pride, Relief, Hope, etc.).

Secondly, we will use Scherer's appraisal theory of emotions to determine the appraisal variables necessary to generate these emotions [34]. Scherer proposes a multilevel sequential approach for the appraisal process. An event will be appraised sequentially by four stimulus evaluation checks (SEC): (1) relevance; (2) implication for self and others; (3) coping potential; and (4) normative significance. Each SEC treats the input information and passes on to the next check (hence the sequential aspect). Moreover, SECs occur on all three levels of the emotion processing system proposed by Leventhal [20]: (1) Sensory motor level; (2) Schematic level; and (3) Conceptual level (hence the multilevel aspect). Lower levels are usually faster to determine a SEC; however, the appraisal information can be inaccurate. For example, a sudden event can trigger surprise followed by fear. Surprise and fear, in this example, are generated by the physiological response to the event without having processed all the information. Later, realizing that the event is not harmful, relief expressed by a laugh is then generated.

Finally, we will link events happening in the environment to the SECs. Events in the environment are triggered by the teacher trainee action which uses emotion regulation strategy. Therefore, to model the relationship between the virtual disruptive student and the environment we will use Interpersonal Emotion Regulation theory (IER) [27]. Niven's classification of interpersonal emotion regulation strategies [27] will be used to categorize the teacherâĂŹs actions. Niven proposes two types of strategies: Affect-improving strategies such as positive engagement, humor, distraction; and Affect-worsening strategies like negative engagement, criticizing, showing disrespect. For each strategy, Niven also provide action prototypes (Criticizing: *"Pointing out the target's flaws"*; Distraction: *"Arranging social activity for the target"*). By mapping IER strategies to Scherer's theory, AIMER will generate a sequence of emotions relevant to the situation based on the emotion regulation strategy applied by the teacher trainee.

**2. Non-verbal behavior generation -** In order to generate realistic non-verbal behaviors such as facial expressions, gaze, head, and body movements, dependent on a virtual student's emotional state, we will analyze freely accessible videos of children displaying emotions. Each video will be tagged with the student's corresponding emotions and facial expressions. Virtual student's head and body movements will be implemented using motion capture and 3D modeling software. The virtual representation will then be iteratively evaluated by a board of experienced teachers using questionnaires and focus groups and refined accordingly until deemed believable. We will use the Behavior Markup Language (BML, [18]) to command the virtual students behaviors.

**3. Action generation -** Once an emotion is generated for a virtual student, an action relevant to its goals and affective internal states needs to be determined. Gross proposes five emotion regulation strategies [15]: (1) Situation selection; (2) Situation modification; (3) Attentional deployment; (4) Cognitive Change; and (5) Response Modulation. For any given event, the virtual student will identify the situation, select a strategy and apply it. Each strategy will be represented by a set of potential actions consistent within the context. Virtual student actions are constituted of two components: (a) Operations (e.g. taking an object, moving to a position); and (b) Utterances (e.g. verbally addressing the teacher or students).

Following an action taken by the teacher to address the disruptive student (e.g. confiscating the phone), first an emotion will be determined by the virtual student internal processes (e.g. anger), which will then generate non-verbal behaviors (e.g. angry expressions, closing hands and, starring at teacher). Finally, based the virtual student's state, an action (e.g. stand up and snatch the phone back) to answer the teacher trainee choice will be selected.

## 3 APPLICATION: MASTER-VR

We will integrate the *AIMER* model within a classroom simulator: Modeling Appraisal-based Student-Teacher Emotional Relationship for teachers' training in Virtual Reality (*MASTER-VR*). *MASTER-VR* optimizes some of Interactive Virtual Training for Teachers [9] (IVT-T) components by building believable virtual students' emotional intelligence. The *MASTER-VR* architecture will consist of the following four main components typically found intelligent tutoring system (ITS) virtual learning technologies: (1) the Domain Model (which promotes validated realistic work scenarios), (2) the Learner Model (which enables to provide tailored feedback), (3) the Pedagogical Model (which uniquely maximizes practice and feedback) and (4) the User Interface (UI) Model (designed for maximum usability and positive user experience, and developed with webGL graphics to enhance browser-independent 24/7 users' access.

## 4 EVALUATION METHOD

In this work, we will study the effect affective behaviors have on teachers while practicing within a VTE. We will consider three measures used in many studies on VTEs [1, 30]: Presence, Engagement and Believability. To assess the effect of affective behaviors on teachers' experience, we will measure user's engagement, sense of presence and perception of the virtual agents' believability.

**Engagement** is defined as *"a value of user-experience that is dependent on numerous dimensions, comprising aesthetic appeal, novelty, usability of the system, the ability of the user to attend to and become involved in the experience and the user's overall evaluation of the salience of the experience"* [29]. Engagement is an aspect of user experience (UX) that goes beyond user satisfaction as the capacity of engaging users in a virtual environment is a crucial factor for e-learning activities using 3D-environment [16, 24]. O'Brien et al., designed the UES-SF (User Engagement Scale - Short Form) [28] composed of 4 categories: aesthetics appeal, focused attention, perceived usability and reward. Using UES-SF we will study the relationship between affective behaviors and user engagement.

The **Sense of presence** is the feeling of "being in there" in the virtual world, and it is generally used when evaluating virtual environments. We are interested in both the physical and social presence of users. Physical presence is defined as the feeling of being in an environment whereas the physical body is situated in another [36]. *social presence*, is defined as a psychological state in which the virtual social actors are perceived as actual social actors [1]. Most researchers posit that presence magnifies the effects of a mediated environment as users responses to virtual stimuli and interactions resemble similar responses to real-world counterparts [7, 35]. We want to determine if the endowment of affective behaviors by virtual students can increase users' feeling of presence.

Researchers argued that representational fidelity, in terms of graphics and behaviors, is necessary to achieve the highest transfer of learning [8]. **Believability** refers to how virtual agents generates an "illusion of life" from a graphical and behavioral perspective [2]. We will adapt a questionnaire designed by Gomes et al. [12] to evaluate the believability of the virtual students. Since believability depends on one's own perception, Gomes et al. implemented a self-report questionnaire focusing on different concepts such as awareness, personality, visual impact, or emotional expressiveness.

Finally, to measure the **transfer of learning**, teachers from elementary schools will be recruited and be randomly assigned to the two different versions of *MASTER-VR*. The Classroom Strategies Scale (CSS; [33] ) will be our direct measure of transfer of training from the virtual to the live classroom. Additionally, Teacher Sense of Efficacy Scale (TSE; [37]) will assess teachers' beliefs about their ability to bring about desired outcomes of student engagement and learning, including students who are difficult to manage or who have low motivation.

## 5 CONCLUSION

In this article we presented an ongoing work to endow a classroom simulators with affective virtual students that are able to display non-verbal behaviors and choose actions based on modeled emotions. We showed our first steps to implement the affective model generation based on appraisal theory of emotions and interpersonal emotion regulation theory. We also describe the context of application of the agent and how we plan to evaluate its impact on immersion, engagement, believability and transfer of learning.

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